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Authors:	Amer Al-Jokhadar, PhD Researcher, Cardiff University Wassim Jabi, Senior Lecturer, Cardiff University
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# Enhancing Social-Cultural Sustainability in Tall Buildings: A Trace from Vernacular Houses | 增强社会文化可持续性发展的高层建筑：遵循传统房屋的足迹



**Amer Al-Jokhadar**  
PhD Researcher | 博士研究生

Cardiff University  
卡迪夫大学

Cardiff, United Kingdom  
卡迪夫, 英国

Amer Al-Jokhadar is a PhD Researcher at the Welsh School of Architecture, Cardiff University. His research concerns constructing a "Socio-Spatial Grammar for Tall Residential Buildings in Hot-Arid Regions: Potentials of Vernacular Architecture in the Middle East and North Africa." He has a Masters in Architecture from Jordan University of Science and Technology. He is a Registered Professional Architect in the Jordan Engineering Association, and he practiced the profession for more than 11 years in a leading consulting company in Jordan, working on large-scale design and urban regeneration projects. His research interests are design processes, parametric architecture, and shape grammars.

AMER AL-JOKHADAR是卡迪夫大学威尔士建筑学院博士研究生。他的研究方向是建造“高温干旱地区高层住宅的社会-空间语法结构：中东及北非传统建筑的潜能”。他硕士毕业于约旦科技大学，是约旦注册建筑师协会成员，并在约旦大型咨询公司从事建筑工作达11年，参与过大型建筑设计及再生空间项目。他的研究兴趣主要在设计过程，参数化建筑，建立空间语法结构等方面。



**Wassim Jabi**  
Senior Lecturer | 高级讲师

Cardiff University  
卡迪夫大学

Cardiff, United Kingdom  
卡迪夫, 英国

Wassim Jabi is a Senior Lecturer at the Welsh School of Architecture, Cardiff University. He has a MArch and a PhD in Architecture from the University of Michigan, Ann Arbor. Dr.Jabi is a past-president of ACADIA and a member of the Editorial Board of the International Journal of Architectural Computing (IJAC). He has published extensively in the area of parametric design and digital fabrication. He is author of the book "Parametric Design in Architecture" (Laurence King Publishing, London, 2013). Dr.Jabi recently received a Leverhulme Trust research grant to research enhancements to the representation of space through topological and computational methods.

WASSIM JABI是卡迪夫大学威尔士建筑学院高级讲师。他在安娜堡密歇根大学取得建筑硕士及博士学位。Jabi博士曾任ACADIA 主席及国际建筑计算杂志 (IJAC) 主编。他发表了大量的参数化设计、数字制造等方面文章。他编写了《建筑参数设计》一书 (Laurence King 出版社, 伦敦, 2013)。Jabi博士最近获得了Leverhulme Trust 研究基金会研究基金, 研究通过更好的拓扑方法和计算方法增强空间表现力。

## Abstract | 摘要

*In the age of globalization and continuous urbanization, architects have a greater responsibility to design buildings with comfortable and sustainable environments. However, solutions should not concern themselves only with utilizing technology, but also with creating synergies among communities' social and historical aspects. This research focuses on the implications of this wider definition of sustainability within the hot arid climates of the Middle East and North Africa. Most of the current tall residential buildings in these regions, in contrast to vernacular courtyard houses, do not promote social cohesion and local identity. Yet, vernacular houses might not be compatible with pressures of modern construction. The question then becomes how to maintain relationships between spatial, social and environmental aspects while employing the latest technologies and materials. Relationships in dwellings are assessed through a typological analysis approach, as a trace of lifestyle and cultural values of the society, to attain parameters that are appropriate for sustainable tall developments.*

**Keywords: Courtyard, Parametric Design, Residential, Social Interaction, Sustainability, Vernacular**

在不断全球化和城镇化的今天，建筑师需要在设计中更多地考虑使用者的舒适度以及环境的可持续性发展。然而解决方案不应仅限于技术层面，更应该考虑当地社会与历史之间的共同关系。本文研究了在中东及北非的高温干旱气候下这种更广义可持续发展的设计方式。上述区域目前大部分的高层住宅建筑与传统庭院房屋相比，无法展示社会凝聚力及本地特色。而传统房屋又无法满足现代住房压力的需求。问题随之变成如何维持空间、社会以及环境之间的关系，同时使用现代科技及材料。本文通过使用类型化分析评估住房关系，来遵循社会生活方式及文化价值，取得参数并帮助发展高层建筑设计。

**关键词：庭院、参数化设计、住宅、社交、可持续性、乡土**

## 1. Introduction

The Middle East and North Africa (MENA) region, which is currently home to 357 million people, has one of the world's most rapidly expanding populations, with more than 60% (215 million) of inhabitants in an urban setting according to statistics of the World Bank (2014). This number, which is expected to reach nearly 400 million by 2050, has been driven by several factors such as economic development, water shortages in rural areas, and displacement of people due to wars. These trends have a significant impact on the built environment and the building construction industry. For instance, global urbanization, scarcity of lands, and high prices increases the demand for affordable living and working spaces, and therefore pushes the emergence of high-rise and high-density developments – which could be considered a hallmark of contemporary cityscape and the most viable solution for many urban centers (Modi 2014).

More than 70% of high-rise developments in the world are located in Asia, the Middle East and Africa (Kearns et al. 2012). Dubai, for

## 1. 引言

根据世界银行统计数据（2014）显示，中东及北非（MENA）目前拥有3.57亿人口，是全世界人口增长最快的地区，其中60%（2.15亿）为城镇人口。而这一数字预计将在2050年增加到4亿。增长基于几方面因素：如经济增长，农村水资源短缺，人口由于战争而导致的迁移等。这些趋势已经严重影响了建成环境及建造业。例如，全球城镇化、土地紧缺及价格增长，对经济适用住房及工作场所的需求的增长，从而促使发展当代城市高层及高密度建筑，这是很多城市中心目前的可行解决方案（Modi 2014）。

全球超过70%的高层建筑都在亚洲、中东及非洲（Kearns et al. 2012）。例如迪拜，2015年以1025幢已完工的高层建筑名列高层建筑最多的第九个城市，阿布扎比、沙迦和多哈分别列于32、33及58位。这些城市的高层建筑建立起了一个具有挑战性的环境，与其他横向建筑相比，对环境既有益处，又有负面影响（Al-Kodmany 2015）。小空间既可以降低成本，减少使用材料，减少热损失/增益，以及整体热岛效应。然而，这限制了使用者与外界环境之间的交流，建立起了一个乏

instance, ranked in 2015 as the ninth city in the world with more than 1,025 completed high-rise buildings, while Abu Dhabi, Sharjah, and Doha ranked 32nd, 33rd, and 58th respectively. These developments create a challenging environment, with both benefits and negative impacts as compared to other types of horizontal constructions (Al-Kodmany 2015). The small area of the envelope could reduce costs, materials, the heat loss or gain, and the overall urban heat island effect. Yet, this limits the contact views between users and the outside environment and sometimes creates isolated and dull boxes. Creating social and shared spaces could increase the interaction with both residents and the environment as it gives access to the natural light and ventilation.

In terms of negative impacts, most of these buildings are constructed as iconic towers that ignore the specifics of the cultural context, lifestyle, living patterns, local traditions, or social and psychological effects on occupancy users (Wood 2013) (Figure 1). Moreover, most of these buildings are more suitable for single-users than for families, the elderly, and children, and do not express the individuality and uniqueness of each family (Al-Kodmany 2015).

In contrast, traditional courtyard houses represent a successful example of a socially cohesive and healthy environment, where both building performance and user requirements could be achieved. Most of these precedents have been designed by

residents themselves as a response to their needs, norms, behavioral, and cultural values. Learning from previous experiences is a good way to design with sensitivity as it provides continuity to the existing context and the cultural roots of the society (Ragette 2003).

Most studies in the field of vernacular architecture have focused on describing the different patterns of houses, while studies on tall buildings have focused on energy consumption efficiency more than studying the social and cultural dimension, such as privacy and hierarchy of spaces (Wood 2013). However, linking the physical form of houses with all environmental, social and cultural aspects could be a useful way for achieving sustainable designs that respond to local context, community, and climate. Therefore, this study aims to understand, analyze, and encode such historical cases in the hot, arid areas of the MENA region, logically and mathematically, and then create a database with parameters and constraints that are useful for designing a contemporary and sustainable tall residential building that traces the social and cultural values of the society.

## 2. The Current Tall Residential Developments in MENA Region

Sustainable development, in general, rests on three pillars: environment, economy, and society, which interact with each other and therefore improve the quality of life. Social

味的隔绝体。建立社交并分享使用空间可以增加使用者以及环境的之间的交流，由此使用了自然光线和自然通风。

具体到负面影响，大部分这类建筑通常都被建造成地标性建筑，却忽略了文化、生活方式、当地传统以及社会和使用者的心理方面的影响（Wood 2013）（图1）。更有甚者，大部分这些建筑更适合单身族居住，而不适合有老人、小孩的家庭，无法考虑到各个家庭的特别需求（Al-Kodmany 2015）。

相对比而言，传统庭院房屋就成功地表述了社会凝聚力和良好环境，建筑功能和使用者的需求同时可以达到满足。大部分这类成功先例都是由居住者考虑自身需求、标准，行为准则及文化价值观自己度身定做。从过去实例中取得经验教训通常是一个好方法，可以敏锐发现问题，并与已有的建筑以及社会文化根源保持一致（Ragette 2003）。

大部分传统建筑研究都关注在描述不同样式的低层房屋上，而对高层建筑的研究总是关注在能源消耗及节能上，并没有研究社会文化方面，如空间隐私及层次上（Wood 2013）。然而，当把房屋物理形态同环境联系起来时，社会文化就变成了达成可持续性设计理念的重要组成部分，体现当地的特色、社区及环境。因此，本文研究致力于理解分析并解码高温干燥的中东及北非区域的历史原因，通过严密的逻辑和数学方法建立带限定条件、带参数数据库，使得设计当代高层住宅建筑遵循社会文化价值观。

## 2. MENA地区高层住宅发展现状

可持续性发展，总体来说有三大要素：环境、经济以及社会。这三者互相作用并因此提高我们的生活质量。社会和文化可持续性在设计过程中综合考虑物理环境（空间布置及形态），使用者的社会需求以及个体的独特性。在设计住宅建筑时，设计师可以通过提供互动空间及环境达到这一平衡，使使用者既保持了隐私性又凸显了特性。而环境可持续性则需要建筑师和工程师考虑各种不同情况以及当地气候，提供热舒适性的同时消耗更少的能源。最后，低运营成本及使用当地建筑材料是达到经济可持续性的重要议题。

高层建筑在小占地面积上建立大体积容量的使用空间。马来西亚建筑师杨经文（Ken Yeang）曾说过，这种建筑可以被定义为“垂直城市”，这就要求设计师在设计过程中需要考虑不同的社会、环境及经济需求。这带来许多好处，如保留城市自然绿色生态，将各种生活设施建设在步行距离内。然而，当地环境、现代住宅建筑趋势、以及居住着的生活模式三者之间



Figure 1. A contemporary tall building (Rotana Tower) in Amman, Jordan (Source: Amer Al-Jokhadar)  
图1. 安曼现代高层建筑（Rotana 酒店大厦），约旦（来源：Amer Al-Jokhadar）



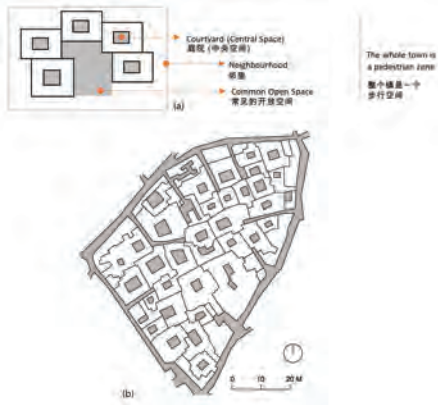


Figure 2. (a) A diagram showing the different components of a traditional town in the study area, (b) A cluster of courtyard houses in Tunis, showing the hierarchy of public and private alleys (Source: (a) Amer Al-Jokhadar (b) Ragette)  
图2: (a) 传统城镇的不同组成元素, (b) 一组展示公共及私人区域的庭院房屋 (来源: (a) Amer Al-Jokhadar (b) Ragette)

and cultural sustainability is about combining the design of the physical environment (spatial layout and form) with the social needs of users and the identity of the place. In residential buildings, designers could achieve this relationship through providing interactive spaces and supportive environments for residents that maintain their privacy and reflect their identity. In terms of environmental sustainability, architects and engineers should consider the different conditions of local climate, which offer thermal comfort and consume less energy. Finally, low operating costs and the use of local materials are major issues that need to be considered to achieve economic sustainability.

A tall building is a large volume built on a small footprint. Ken Yeang claims that this building could be defined as a “vertical city,” which requires designers to take into account different social, environmental, and economic requirements during the design process. Many benefits could be achieved such as preserving natural and green spaces in the city and locating various services within suitable walking distances from units. However, there is a gap between the local context and the climate of contemporary residential buildings as well as the appropriate living patterns for residents. In most of these developments, the hierarchy of open and semi-open spaces and the existence of nature are limited and marginal. As a result, these buildings depend on the use of cooling and heating mechanical devices in different spaces instead of natural resources such as wind and sun. Moreover, developments in recent years do not reflect a realization of social spaces as a high priority. Although there is a trend of inserting a central atrium, it is not exposed to the daily life, so it seems to be lifeless.

Socially sustainable high-rise housing needs a smart and sensitive approach associated with the ideals and expectations of its users and the ability to deliver the local lifestyles for residents. One approach to deal with these issues is to incorporate the local tradition and the potentials of vernacular architecture in the design of tall buildings. Ken Yeang, for example, bases his works on the adaptation of regionalism through the understanding of traditional values without the direct use of traditional forms and materials.

### 3. Sustainability in Traditional Neighborhoods and Vernacular Houses in MENA Region

Throughout different ages, people in any culture have developed particular ways to construct dwellings and domestic spaces related to their practical experiences of living in a specific location and dealing with local materials, micro-climate, and context. Oliver (2003) expressed this vernacular environment as a “theater of our lives,” where different scenes of daily events take place. This native process is dynamic and has many variations with specific patterns, logic, customs, and values (Bianca 2000; Oliver 2003). With time, these vernacular dwellings became a “tradition” and a “philosophy of life” that passed on from one generation to the other within family and community (Ragette 2003).

#### 3.1. Sustainability at the Scale of Residential Neighborhood

The layout of traditional neighborhoods in the study area (e.g., Cairo, Tunis, Aleppo, Medina, Algeria, Fez, and Marrakech) usually form an irregular pattern and have more than one focal center. However, the organic spatial configuration of these quarters produces a homogeneous urban fabric and balanced townscapes that are determined by specific social and religious principles (Bianca 2000). The traditional public squares allow for a high degree of social interaction between people and reflect their sense of community. The access from public areas to residential quarters is usually broken into hierarchical sections to increase degrees of privacy and at the same time maintain a balance between isolation and interaction. This pattern has been gradually controlled by different intermediate tools, such as dead-end alleys and a gradual sequence of gateways to protect private family domains and prevent conflicts with the public realm (Bianca 2000) (Figure 2). Moreover, the layout reduces external heat gain or loss and blocks

存在分歧。在大部分情况下,使用开放空间还是半开放空间是被自然环境局限的。因此,这些建筑取决于暖通机械设备而不是自然风能或太阳能。并且近年来,人们并不优先考虑社会空间。尽管目前的趋势是在建筑中设计中庭,但它并不没有使用在日常生活中,因此变得了无生命力。

高层住宅的社会可持续性要求智慧并敏锐感知使用者的期望,并能够设计出适合本地生活方式的产品。一种方式是通过将当地传统和潜在传统建筑融合在高层建筑中。如杨经文(Ken Yeang)的设计既基于适应当地特色,理解传统价值观,又不直接使用传统建筑方式与建筑材料。

### 3. MENA地区传统邻里和传统建筑的可持续性

在不同的时期,人们在任何文化下都有他们独特的建造居住场所的方式,这些方式体现了他们在具体不同地域的生活经验,使用当地材料,对微环境和其他环境的处理。Oliver (2003)对这个传统环境为“我们生活的剧场”,日常生活的不同场景尽被演绎。这些过程都是动态的,并在具体的形态、逻辑、传统和价值中又有所变化(Bianca 2000; Oliver 2003)。随着时间流转,这些普通住宅变成了“传统”和“生命的哲学”,伴随着家庭和社会传承了下去(Ragette 2003)。

#### 3.1. 社区邻里的可持续性

传统的邻里关系(如开罗、突尼斯、阿勒颇、梅迪纳、阿尔及利亚、非斯和马拉喀什)通常都是不规则的,并且都有多于一个市中心。这些有机空间组成造成了均匀城市纹理,并平衡了城市风貌,体现了社会和宗教主旨(Bianca 2000)。传统的公共广场允许高度的人与人之间的社会互动,并反映他们的社区感。从公共场所入口到居住区域通常被分为几个明显区域,来增加隐私度,同时平衡了隔绝及互动关系。这种模式由不同的中间媒介来控制,如分支路线以及不同级别的门禁(图2)来达到保护家庭隐私的目的,并避免了与公共区域之间的冲突(Bianca 2000)。此外,这种布局减少了外部热增益及热损失,阻止过多的空气流通带来沙子和灰尘(Ragette 2003)。在社会回报方面,避免了与邻里的纠纷,家庭隐私和安全性通过视觉障碍的到了保障(Mortada 2003),采用高墙和房间之间的错位来避免窗户开向邻居屋顶(Ragette 2003; Bianca 2000)。

在基本层面上,这种整体的社会及环境优势的传统水平布局有可以通过划分成不同层次转换为垂直布局,这一方案高度促进

excessive air movement which carries sand and dust (Ragette 2003). In terms of social rewards, disputes with neighbors are avoided and the privacy and security of families are preserved through visual barriers, such as the principle of staggered entrances (Mortada 2003), the use of high walls and setbacks between houses, and avoiding window opening towards neighborhood roofs (Ragette 2003; Bianca 2000).

On a basic level, the overall social and environmental qualities of such traditional horizontal quarters could have the potential of being transferred into vertical arrangements by dividing it into layers as a representation of a neighborhood in a traditional fabric. This solution could highly promote the concept of hierarchy and clustering that create a mutual responsibility for common spaces as semi-public areas in each segment for encouraging interaction between neighbors.

3.2. Sustainability at the Scale of House and Residential Unit

On the scale of the residential unit, the spatial configuration of dwelling layouts varies according to different periods, regions and cultures. Traditional dwellings in hot, arid regions are inward-looking houses with living spaces organized around a central space (courtyard) and opened to the sky. Most dwellings have one courtyard (atrium house) and sometimes more (patio house) (Figure 3). The main courtyard is usually for the family and located on the ground floor. The other one acts as an entrance open space with a staircase leading to upper floors.



Figure 3. Different layouts of traditional houses in the hot, arid regions of the Middle East and North Africa (Source: Ragette)  
图3：高温干燥区域传统房屋的不同布局（来源：Ragette）

Many dwellings have porches, galleries and balconies that connect spatially the indoor environment with the outside while preserving their purposes as extensions of the domestic living space. Moreover, spaces are dynamic through using different techniques such as changes in levels, directions, and degrees of openness (Ragette 2003). This relationship between indoor and outdoor spaces and the use of transitional zones between public and private areas are key qualities in the spatial arrangement of the house to maintain social needs (such as privacy) and environmental qualities for family members (Oliver 2003). The following illustrates briefly the different dimensions of sustainability (social-cultural, environmental, and economic) at the scale of a house in an attempt to reflect these issues in the design of tall buildings (Figure 4).

Social-Cultural Dimension

Several studies conducted by architects, planners and sociologists outline that traditional houses afford many social rewards for people and families who occupy them.

a. Privacy and Spatial Hierarchy

Spatial elements and treatments, such as courtyards; arrangement of transitional spaces and internal circulation; proper distribution of openings; the bent entrance passageway from the street; and hierarchy of spaces from public to private and from formal to less formal, are important considerations for family activities in residential units to attain maximum privacy (visual, acoustical and olfactory) (Mitchel 2010).

层次理念，在各单元创造半开放区域促进邻里互动。

3.2. 住宅单体可持续性

对于住宅单元，住宅空间布局随着不同的时期、区域和文化而变化。在高温干旱地区的传统民居是内向型的房屋，房屋设置围绕一个中心空间（庭院）露天。大部分住宅有一个庭院（中庭），有时更多（多庭院住宅）（图3）。主庭院通常服务于家庭并设置在低楼层。另一个庭院作为开放空间入口，通过楼梯连接上层。

许多住宅都有门庭和阳台都与外界连接空间的室内环境，来作为室内生活的延续。此外，空间是通过使用不同的技术，如改变高度、方向、开合而变得动态（Ragette 2003）。室内和室外空间关系、使用公共和私人空间的过渡关系是房屋保持社会需求（如隐私等）、环境质量和人际关系的关键点（Oliver203）。下面简要地阐述了房屋可持续发展的不同维度（社会文化、环境和经济）展现出设计中存在的这些问题（图4）。

社会文化维度

建筑师、规划师以及社会学者经过多方研究指出传统房屋带给居住者的优点。

a. 隐私和空间层次性

空间元素和处理方式，如庭院，过渡空间和内部通道设计，合理的门窗位置主入口开口方位从公共区域到私人区域，从正式场所到非正式场所等，都是住宅的居住者获得最大隐私性考虑的最重要的几个因素（视觉，听觉和嗅觉）（Mitchel 2010）。



Figure 4. Dimensions of sustainability at the scale of vernacular courtyard houses (Source: Amer Al-Jokhadar)  
图4：传统庭院房屋的可持续性维度（来源：Amer Al-Jokhadar）



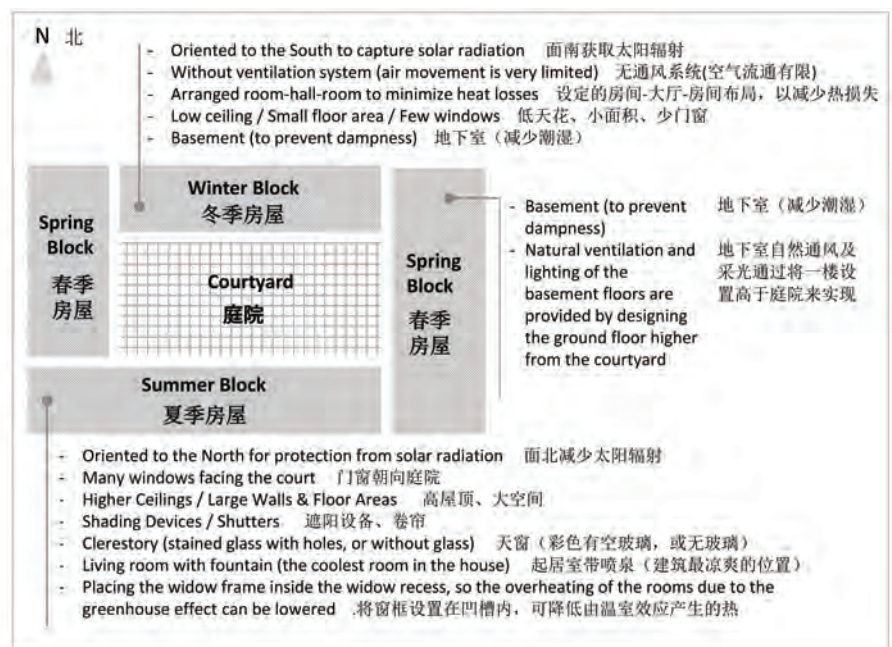


Figure 5. Zoning for a typical traditional courtyard house in hot, arid regions (Source: Amer Al-Jokhadar)

图5. 高温干燥区域典型传统庭院房屋的区域 (来源: Amer Al-Jokhadar)

#### b. Social Interaction and Family Ties

Social interaction between family members and allowing children to play without disturbing their neighbors could be easily encouraged through courtyards and semi-private domains. In large houses – and in order to have strong family ties when the descendants get married – the spatial arrangement could be extended horizontally in semi-independent sub-units, or vertically where each generation occupies a story (Mortada 2003).

#### c. Social Fairness and Integrity

Most residential units are generally similar in their form and spatial arrangement. Nothing on the exterior blank walls of these houses shows the social or economic status or the composition of the family inside (Mortada 2003). Such a matter relates indirectly to the religious beliefs of the community which stresses the issue of not exhibiting differences between people.

#### d. Modesty

Due to the small plot area, and to achieve the principle of modesty and humility, which is a prevalent cultural value in the region, spaces inside houses are modest in their sizes in relation to their actual use. The area of each space is neither small nor exaggerated. However, spaces with mixed-functions are the main feature in vernacular architecture. Rooms such as living and dining rooms serve different purposes at different times of day and night. Moreover, eliminating excessive decoration in the house is another response to the principle of humility (Mortada 2003).

#### e. Hygiene

In most residential units, gates and thresholds define the private zones. This change in level protects houses from dust. Inside the house, steps that separate clean sitting areas from depressed floors where shoes and tools are placed, is also a response to that requirement.

#### f. Spirituality

Sometimes, the orientation of spaces inside dwellings to qibla (which is the direction that should be faced when a Muslim prays) has a symbolic and specific meaning of spiritual focus (Oliver 2003).

### Environmental Dimension

In hot, arid regions, where the harsh environment, high temperatures, and scarcity of water and plants are common features, residents prefer to close their dwellings to the outside by introducing a courtyard, which could achieve a balance between the body and the environment.

In terms of spatial distribution, rooms are placed according to their use during the year. Summer rooms are located on the south side of the courtyard and oriented to the north direction. This solution protects these spaces from solar radiation and heat absorption, and acts as a barrier to the north winds to reduce heat losses for the northern part of the house, where rooms for winter use are located to capture solar radiation from the southern direction (Ragette 2003). Spaces for spring and autumn seasonal use are usually placed on the east and west sides of the court (Figure 5).

#### b. Social and Family Relations

家庭成员之间的社交, 容许儿童尽情玩耍却不打扰别人, 这一点可以通过庭院设计半私人邻域来实现。在大房子中, 当后代结婚后为了维系家庭关系, 空间格局可通过横向延伸变成半独立单元, 或垂直布局使每代人住一层 (Mortada 2003)。

#### c. Social Fairness and Integrity

大部分住宅单元通常都在形态和空间布局上是相似的。仅从外墙无法判断这些住宅之间的社会经济差别或内部家庭组成差别 (Mortada 2003)。这一情况不会直接表现出人们之间不同的宗教信仰。

#### d. Modesty

这些区域流行的文化传统价值是谦虚和谦逊。由于空间小, 住宅空间与实际用途相比大小应适中即可。空间不可过大也不可过小。多功能空间是这种传统建筑的特色。起居室、餐厅这样在每天不同时段做不同用途。另外, 减少多余装饰也是展现谦虚的另一个部分 (Mortada 2003)。

#### e. Cleanliness

在大部分住宅单元中, 大门和墙划分了私人区域领地。这些界线也保证室内灰尘度。在室内通过阶梯高差区分相对干净的起居空间和低处放置鞋和工具的空间, 也是满足卫生程度需求的解决方案。

#### f. Religiousness

有时住宅内部空间“朝向”(穆斯林朝拜时面对的方向)是具有象征性和特定含义的心灵寄托 (Oliver 2003)。

### 环境维度

在高温干旱地区环境艰苦, 由于温度高, 水资源及植物缺乏, 居住者更倾向于对外界封闭, 引入庭院设计, 由此实现人与环境两者之间的平衡。

在空间分布上, 房屋根据其一年当中的用途进行布置。夏季房设置在庭院的南边, 朝向北方。这一方案可减少太阳辐射和热吸收, 并作为屏障阻挡北风带来的热损失, 冬季房则需要面南摄入热辐射 (Ragette 2003)。春秋房通常设置在庭院的东西两侧 (图5)。

其他处理冷热和空气湿度的方法包括: 使用水景, 在房屋低处设置水罐; 设置冷却板, 让水滴在大理石表面; 软硬景观; 设置半开放房屋 (伊万) (Oliver 2003)。此外, 风塔可有效防止灰尘和噪音进入室内, 并引入新鲜干净的冷风到低处的起居室, 从而传递至庭院, 这一方式在海湾地区尤为有效。

Other treatments for cooling and humidifying the dry air include: the use of water features and jugs at the lowest part of the house, cooling plates which allow the water to drop on a marble surface, soft and hard landscaping, and the insertion of semi-open rooms (iwan) (Oliver 2003). Furthermore, wind towers (malqaf or badgir), especially in the gulf area, are useful elements that prevent dust and noise from entering while encouraging the fresh, cool and clean air to transmit to the lower living rooms and then pass to the courtyard.

### 3.3. Sustainability in Vernacular Tall Buildings

Historically, the need to preserve land in the city, achieving security for residents, and showing off prestigious status are contributing to the trend that creates residential buildings with more than three to four stories, and sometimes ten floors in traditional cities. Some of the most notable old tall buildings in the world are found in Shibam, Yemen, South-Arabian Mountains, and Morocco (Ragette 2003). Shibam is “the oldest skyscraper city in the world” with more than 500 vertical houses, originating from the 16th century and made out of mud-brick (Figure 6). The whole building is a “multi-floor family tower” and is occupied by one family. Each tower has a small yard at lower levels, and a vertical separation of functions. Storage

areas and stables are located on the ground level with small windows, then a vertical sequence of kitchen and toilets on the first or second floors, then living spaces for the family, reaching to zones for men and their guests (Ragette 2003).

### 4. A Syntactic-Geometric Model for Encoding Traditional Houses as a Trace of Social and Environmental Qualities

Generally, a successful design incorporates an identity, which is related to the design of all components in harmony with context, climate, traditions, needs, and requirements of contemporary and future needs (Mehrpooya et al. 2015). One method for dealing with this issue is using a “typological analysis approach,” as it provides an understanding of the space-form language and the different characteristics of locality and environment, and offers for the architect a database that includes spatial arrangements, parameters and rules that trace the social and environmental dimensions of dwellings.

A developed model for “syntactic-geometric analysis” depends on combining the “space syntax method” with three aspects of design: (a) analyzing the geometric characteristics of spaces (shapes, areas, and proportions); (b) identifying social indicators (relationships, users, privacy, patterns of movement, and distances between spaces); and (c) specifying

### 3.3. 传统高层建筑可持续性

在历史上，城市住宅建筑超过三到四层、甚至十层主要是为了保有土地，彰显尊贵地位。其中世界上最有名的高层建筑群之一在也门希巴姆，南阿拉伯山脉，以及摩洛哥（Ragette 2003）。希巴姆是“世界上最古老的摩天大楼城市”，拥有超过500座垂直建筑，最初始于16世纪由泥砖建造（图6）。整个建筑是一个“多层家族塔”，居住着一个家族。每个塔在低楼层都有小庭院，并有垂直隔断作用。储藏室和马厩位于底层，带窗户。然后垂直方向按顺序排列二层厨房，三层卫生间，然后是家族起居空间，延伸至男性及其客人区域（Ragette 2003）。

### 4. 解码遵循社会环境质量设计传统建筑的句法几何模型

通常情况下，一个成功的设计意味着它“独特”（Mehrpooya et al. 2015）。这个问题关系到设计的各方面的与周围环境、传统、现代生活及未来生活的需求相和谐。处理这个问题的其中一个方法是使用“类型分析法”，这种方法解读了空间形式以及当地独特特性与环境，并为建筑师提供了包括空间布局、参数以及遵循社会环境维度住宅的数据库。“句法几何分析”模型有三方面与“空间句法”相关：（a）分析空间几何特征（形状，面积以及比例）；（b）确定社会指标（关系、用户、隐私、运动模式、各空间之间的距离）；以及（c）指定环境解决方案（如朝向、建筑外形）。该模型有五部分组成（图7）：



Figure 6. Vernacular tall residential buildings in Shibam, Yemen (Source: Jialiang Gao)  
图6. 也门希巴姆传统高层住宅（来源：Jialiang Gao）



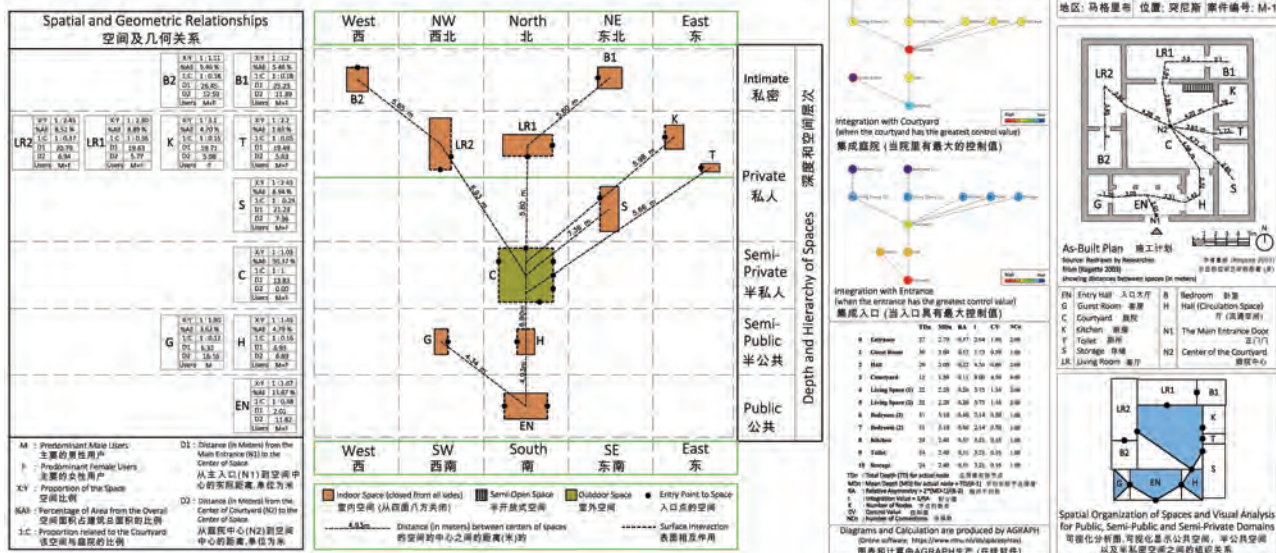


Figure 7. A syntactic-geometric model for analyzing a vernacular house in Maghrib (Source: Amer Al-Jokhadar)  
图7. 马格里布传统房屋的句法几何分析模型 (来源: Amer Al-Jokhadar)

environmental solutions (e.g., orientation and type of enclosures). This model has five components (Figure 7):

**As-Built Plan:** showing patterns of movement and actual distances (in meters) between the center of the courtyard and the center of spaces passing through doors (Figure 8).

**Visual Analysis Diagram:** showing the spatial organization of spaces with visual connections between public, semi-public, and semi-private domains.

**Space Syntax Analysis:** calculations with two diagrams, produced from AGRAPH software, which is an online analytical platform, showing spatial relationships between spaces, courtyard, and entrance. Calculations showing the following measurements:

- Connectivity (NCn), which measures the number of immediate neighbors that are directly connected to space.
- Integration value (I), which describes the average depth of space to all other spaces in the system. The spaces of a system can be ranked from the most integrated to the most segregated. The highest value indicates the maximum integration.
- Control value (CV), which measures the degree to which space controls access to its immediate neighbors, taking into account the number of alternative connections that each of these neighbors has.

**Depth and Hierarchy of Spaces:** which are represented through its actual shapes and proportions, and arranged to show the hierarchy (public, semi-public, semi-private,

**施工计划:** 庭院中心到各使用空间通行的行动模式及实际距离 (图8)。

**可视化分析图:** 可视化显示公共空间、半公共空间以及半私密空间之间的组织关系。

**空间句法分析:** 使用AGRAPH软件 (在线分析平台) 生成两个图表, 显示空间、庭院及入口之间的空间关系。计算显示下列值:

- 连接性 (NCn), 测量直接连接至空间的住户数。
- 整体值 (I), 描述空间相对系统其它空间的平均深度。各系统空间可按照

最整体至最分散排序。值越高表明整体化越高。

c. 控制值 (CV), 测量哪一个空间控制着至其邻居的通道, 并考虑这些邻居有可能使用其他节点。

**深度和空间层次:** 通过其实际形状和比例来展示空间层次 (公共、半公共、半私人、私人、私密); 方位 (西 (W)、东 (E)、北 (N)、南 (S)、东北 (NE)、西北 (NW)、东南 (SE) 及西南 (SW)); 相邻空间的公共面; 各空间入口, 以及空间中心至相邻空间中心的实际距离 (图9)。

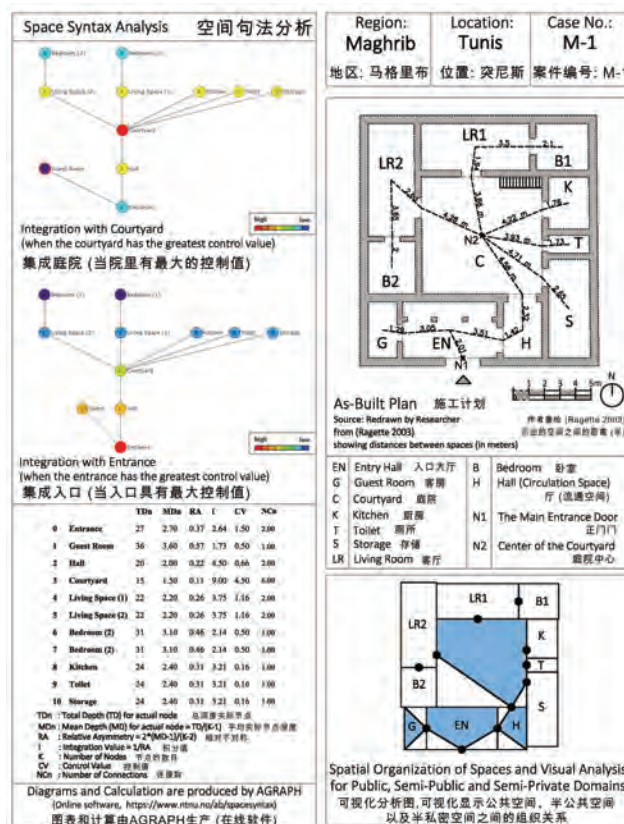


Figure 8. As-built plan, space syntax analysis, and visual analysis diagram for a vernacular house in Maghrib (Source: Amer Al-Jokhadar)  
图8. 马格里布传统房屋的施工图、空间句法分析及视觉分析图 (来源: Amer Al-Jokhadar)



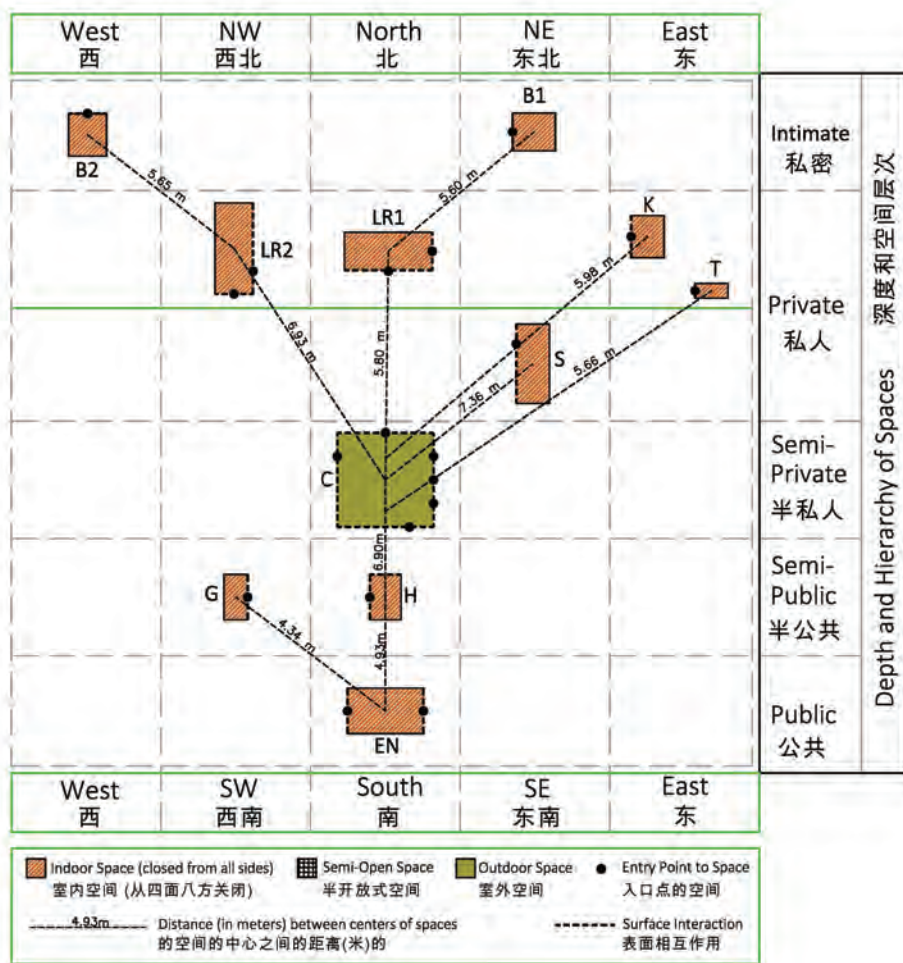


Figure 9. Analyzing the depth and hierarchy of spaces for a vernacular house in Maghrib (Source: Amer Al-Jokhadar)  
图9. 马格里布传统房屋深度及空间层次分析 (来源: Amer Al-Jokhadar)

private, and intimate); orientation (west (W), east (E), north (N), south (S), northeast (NE), northwest (NW), southeast (SE), and southwest (SW)); shared surfaces between adjacent spaces; the entry access of each space; and the actual distance between the center of spaces and the center of adjacent rooms (Figure 9).

### Spatial and Geometric Relationships:

showing different calculations which include proportion of each space (X:Y); percentage of the area of a space from the overall area of the house (%ALL); proportion of that space related to the courtyard (1:C); actual distance (D1) in meters from the main entrance (N1) to the center of the space; actual distance (D2) from the center of the courtyard (N2) to the center of the space; and the dominant users of each space (Male (M), Female (F), or Both (M+F)) (Figure 10).

Based on this syntactical-geometric model of analysis, it is obvious that the human spatial behavior, the social life inside the house, the hierarchy of spaces, and the segregation and seclusion of family members from male visitors are regulated by a series of syntax elements. The following are some of the major observations:

- The space syntax analysis shows that the courtyard, which is a semi-private space, has both the greatest control value (CV = 4.50) and the greatest integration value (i = 9.00), which means that other spaces, mostly private zones, are controlled and accessed through the central space of the house, where most of the daily functions are located. This arrangement provides a suitable area for family gatherings, with protection from direct views from the outside.
- The hall (H), which is a semi-public circulation space, connects the entrance with the main courtyard. It is a mediator between the inside of the house and the outside world. However, the bent entrance passageway preserves the visual and spatial privacy of the family.
- The guest reception room is a shallow space used for male visitors, and it has the lowest integration value (i = 1.73), as it is situated off the courtyard and next to the entry hall. There is no visual connection between this space and the semi-private and private domains, so the privacy of the family members is achieved.
- Most spaces follow the geometric patterns of the courtyard with a symmetrical layout arrangement.

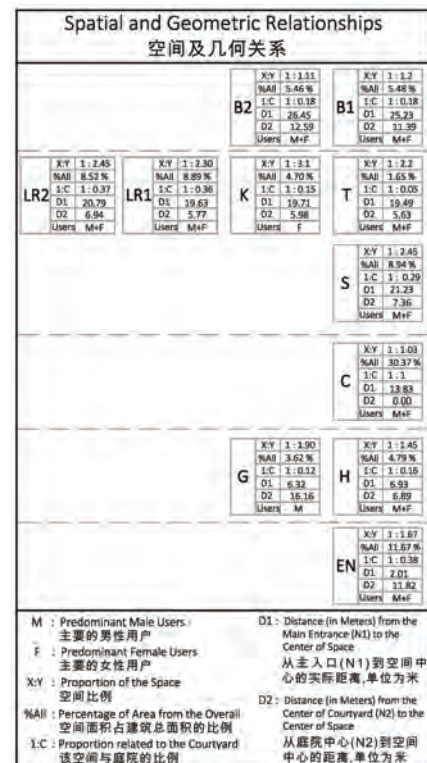


Figure 10. Analyzing spatial and geometric relationships for a vernacular house in Maghrib (Source: Amer Al-Jokhadar)  
图10. 马格里布传统房屋空间及几何关系分析

(来源: Amer Al-Jokhadar)

**空间及几何关系:** 体现各空间比例的不同计算值 (X:Y); 空间面积占建筑总面积的比例 (%ALL); 该空间与庭院的比例 (1:C); 从主入口 (N1) 到空间中心的实际距离 (D1), 单位为米; 从庭院中心 (N2) 到空间中心的距离 (D2); 以及空间的主要使用者 (男性 (M)、女性 (F) 或所有 (M+F)) (图10)。

基于这种句法几何模型分析, 人类空间行为、房屋内的社会生活、空间阶层以及将家庭成员与男性访客隔离等要素会通过一系列句法单元进行规定。以下为主要的 结论:

- 空间句法分析显示半私密空间庭院同时有最大控制值 (CV=4.50) 和最大整体值 (i=9.00)。这表明其他日常生活的大部分私密区域是由房屋的中心区域控制通行。这种布局为家庭集会提供适当场所, 并不会从房屋外直接被看到。
- 走廊 (H) 为半私密流通区域, 连接总出入口和庭院, 为室内和室外的中介。回形走廊可以保护家庭的空间私密性, 不被外界看到。
- 客人接待室是男性访客使用的小空间, 整体值最低 (i=1.73), 设置在庭院旁边紧靠入口走廊。该区域应不会看到半私密及私密区域, 由此保持家庭成员的隐私性。
- 大部分区域根据庭院几何特征呈对称布置。
- 所有私密区域面向庭院, 其入口至庭院中心的距离应大致相同。此距离在5.65m至7.3m之间, 为居住着舒适的距离范围。

- All private spaces face the courtyard and have approximately the same distance between the center of the courtyard and the entry point of that space. This depth, which ranges between 5.65 and 7.30 meters, provides a suitable distance for the residents to feel comfortable.
- All intimate spaces (bedrooms) should be accessed through private spaces to give more privacy.
- Services (kitchen, toilets, and storage) are placed on the eastern part of the courtyard.

This analytical information needs to be translated into rules and constraints that are useful for generating parametric solutions. This process will be conducted in the next stages of this ongoing research, which aims to construct a socio-spatial grammar for tall buildings in MENA regions. Such a grammar will include (1) shape grammars that reflect shapes, vocabularies, proportions, geometric properties, and formal rules; and (2) programming grammars that define design briefs and descriptions.

## 5. Conclusions

In general, the design of buildings is a challenge for the architect to be sensitive in reflecting the needs of users that are specific for the context and at the same time providing them with comfortable conditions. This study aims to create a database that helps the architect in designing a tall residential building that promote social, cultural and environmental sustainability.

The study shows that most of the current tall buildings in the Middle East and North Africa lack the identity of the place, while most of the traditional houses are good examples of a socially cohesive and healthy environment. Many aspects, such as hierarchy of spaces; different degrees of openness and enclosures; the courtyard; the use of soft and hard landscaping; the specific use of spaces; patterns of movement; and geometric properties of spaces, could help the architect in specifying the social, spatial and environmental parameters that should be integrated in the design process of contemporary sustainable buildings. The typological analysis of such historical cases using a syntactic-geometric model is the first for identifying the design brief and the parametric rules for generating different solutions with respect to the identity of the place.

- 所有特别私密空间（卧室）应通过私密空间进入。
- 设施（厨房、厕所及储藏室）应设置在庭院东部。

这些分析信息需要被翻译成约束条件来进行参数化分析。这一过程将在后续研究中进行，旨在建立MENA地区高层建筑社会-空间语法规则。该语法规则将包括（1）建立法则显示形状、艺术、几何属性、正式规则，以及（2）编制语法规则，定义设计准则及理念。

## 5. 结论

总而言之，建筑设计对建筑师来说是一项具有挑战性的工作，需要敏锐反映使用者的具体需求，同时提供舒适度。本研究目的在于建立数据库，帮助建筑师设计高层建筑时提升其社会、文化及环境可持续发展性。

研究表明目前大部分中东及北非地区高层建筑缺乏特色，而传统建筑却恰好是社会凝聚力和健康环境的优良范例。在很多方面，如空间层次，不同程度的开放和封闭，庭院，软硬景观，特定使用空间，通行方式，空间几何属性可以帮助建筑师鉴别社会、空间及环境参数，从而整合在设计现代绿色建筑的过程中。历史上使用句法几何模型的类型学分析已经显示该方法可有效确定设计方案，参数化设计可为特色设计提供不同解决方案。

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